A STUDY OF THE GROWTH, DEVELOPMENT, AND REACTIONS OF YOUNG GREAT HORNED OWLS (BUBO VIRGINIANUS VIRGINIANUS).

by

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Submitted to the Department of Zoology and the Faculty of the Graduate School of the University of Kansas in partial fulfillment of the requirements for the degree of Master of Arts.

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I N D E X.

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I. Introduction.

In this study are presented observations and data on the growth, development, and reactions of young Great Horned Owls (Bubo virginianus virginianus) (A. O. U. Check List 1910). When a rather unusual opportunity arose for such a study, a perusal of the literature covering previous studies showed that in this particular field very few observations are reported which deal directly with this special problem.

Wilson and Bonaparte (1831) described the great horned owl in its adult stage, recounted superstitions relating to it, and made brief mention of its habits. Audubon (1832, 1849) discussed the species, interspersing the discussion with a brief delineation of American scenery and manners, and along with its field habits gave some anatomical data. A brief description of the owls as a group, stressing some of the anatomical features, and a paragraph on this particular species, composed largely of an illustration regarding the superstitious awe of it, was given by Cassell (1854). A more complete treatise on the structure and classification is presented by Beddard (1898) in a comparative manner. Fisher (1893)

made an excellent resume of all previous literature dealing with the great horned owl. This consisted mainly of field observations, laboratory studies and anatomical data along with characteristics of the species; but he mentioned only briefly the young, and did not touch upon reactions at all. Probably the most complete study of the physiological features of birds in general with some mention of the owls is that by Beebe(1906). Bailey (1918) in his account of raptorial birds deals with the range and general habits.

A new departure is taken by Job (1905) in his photographic adventures. He has some excellent photographs of the great horned owl at nesting time but his account deals with his adventures and contains practically no observations concerning the development of the young. The most detailed account of the nesting habits and of the nestlings is given by Keyes (1911). It is largely a nest history of certain pairs found breeding in Iowa. Dixon (1904) likewise relates the history of a pair on the Pacific Coast (Bubo virginianus pacificus). A very brief account of observations made on a young owl in captivity is given by Banks (1884).

All other sources are more or less isolated reports of limited observations, most of which have but little bearing on the present discussion.

II. Range of the Great Horned Owl.

Wilson and Bonaparte (1831) without reference to the geographical races of this species assigned it to almost every quarter of the United States. Audubon (1839) stated it to be a resident from Texas northward and not rare in the south. According to Fisher (1893) the great horned owl is found in suitable localities throughout the greater part of North America, Costa Rica, as far as known being the southern limit of its range. He recognizes that the species is modified by climate and other influences so that it is separable into several well-marked geographical races. The typical form, Bubo virginianus virginianus, ranges from Labrador and the eastern United States south through eastern Mexico to Costa Rica. This is practically the same range assigned by Chapman (1912) and others. N. S. Goss (1886), Snow (1903), Bunker (1913), and Douthitt (1918-19) all class it as a common resident of Kansas.

III. Nest Habits.

The heights of the nests vary from ten to ninety feet above the ground although the usual height is generally from twenty-five to forty feet (Bendire, 1892). The open nests are often slovenly structures, frequently so fragile that they fall to pieces before the nestlings are ready to leave them. Job (1905) found an adult brooding an owlet in the bare fork of a tree where a little dirt was all that was left of the nest. Wayne (1910) gives one instance where the eggs were deposited on the bare wood in a very slight depression formed by the junction of five huge limbs of a giant pine. Cook (Butler, 1897) records one case where a pair of great horned owls and a pair of red-tailed hawks occupied the same nest at different times during the same season. This, he remarks, had been kept up for years, the former using it in February and the latter in April. Besides nesting in old open nests and cavities of trees they may also be found on the plains or treeless portions of the state (Kansas) in fissures of rocks, scantily lined with leaves and grasses (Goss 1886). As Coues (1887) stated, the owls are among the most cosmopolitan of birds; with minor modifications according to circumstances, their general habits are much the same the world over.

As a rule the nest when owlets are present is far from sanitary. It is no unusual occurrence to find dead rabbits, skunks, rats and rodents of various kinds lying about to appease the appetite of the nestlings. Barrows (1912) found in one nest with two young a mouse, a muskrat, two eels, four bullheads, a woodcock,

four ruffed grouse, one rabbit, eleven rats, the whole weighing eighteen pounds.

The species is practically non-migratory (Knight, 1908). It becomes attached to certain localities and seldom wanders from them even in cases of extreme persecution. As a usual thing they will, should their nest be disturbed, take another in the immediate vicinity and after a season or two return again to the first one (Bendire 1892.-Ralph.). The same observer (Ralph) mentions the fact that a third set of eggs was laid after the first two sets were taken. Keyes (1911) likewise found another setting after he had removed the first. Anderson (1907) also verifies this observation.

All evidence points to the fact that there is but one brood a season (Fisher 1893). The young leave the nest in May or early June (Bailey 1918); Dixon (1904) gives seven weeks after hatching for two nestlings which he had under observation. Keyes (1911) has four weeks for one brood but this is explained by the fact that the first setting of eggs was taken and for that reason the hatching time was delayed till late in the season. As a rule broods that hatch early stay longer than that.

Dixon (1904) met with no trouble from the adult birds during his different visits to the nesting site; Job (1905) gives the same experience although he mentions various incidents where this has not been the case. Keyes (1911) found the old birds quite pugnacious, often attacking the intruder with both wings and claws. As a rule this species may be counted upon to defend its home.

IV. Incubation Period.

There seems to be a slight difference of opinion concerning the incubation period of this species. Older ornithologists (Baird, Brewer, and Ridgeway 1874, Coues 1887) made a guess at about three weeks. Keyes (1911) did not determine this point but from his data concluded that it could not be less than thirty days. Dixon (1904) decided from his observations that the period extended over twenty-eight days; while Bendire (1892) expressed his belief that four weeks was probably the correct time. A more recent observer, Donahue (1923), found the period for one nest to be twenty eight days after the three eggs were laid; on January 19, 1923 there had been two eggs in the nest; on January 21 there were three eggs and on February 17 one owlet was hatched, one egg pipped and the other egg showed no external change. This compares quite favorably with the observations made on the particular nest herein discussed. On January 30, 1922 three eggs were in the nest in the old cottonwood. Later, on March 19 there were three young birds in the nest at which time Number 2 was taken. By comparisons with other birds of this species this nestling was estimated to be about three weeks old. This would place the hatching time the last few days of February, making the incubation period at least four weeks.

Opinions likewise vary as to the number of eggs in a set. Wilson and Bonaparte (1831) gave the number from two to four. Bailey (1913) and Knight (1908) agree with this although Knight states that the number is usually three. White (Macoun and Macoun 1909) and Chapman (1912) fix the number from two to three and Bendire (1892) says

one to five. He further states, however, that extra large sets are sometimes found due to the fact that the first eggs are often spoiled by freezing; quite often where this is the case, the first eggs will be found pushed down into the rubbish of the nest. During severe weather the eggs are not infrequently ruined by freezing (Gossard and Harry 1912).

It is believed by some (Keyes 1911) that one egg is laid every two days. Donahue (1923) found this to be true in the case of his one study. Dixon (1904), however, records two instances where a period of four days intervened between the laying of the first and second egg. Bendire (1892) gives the time as about three days between the laying of each egg. The weather conditions at the time of laying makes it quite probable that the owls begin incubation with the first egg. Allen (1918) states that this is the case and that sometimes both male and female will be found sitting on the nest at the same time.

The eggs are almost globular, pure white in color, and measure according to various authorities (Wilson and Bonaparte 1831; Knight 1908; Chapman 1912) 2.25 by 1.75 inches; 2.08 by 1.79 inches; 2.20 by 1.80 inches.

V. Origin and Description of Subjects Studied.

The material upon which this study is based consisted of four young great horned owls, two of which were known to have come from the same nest in two successive seasons. In the nesting season of 1919 a pair of great horned owls (Bubo virginianus virginianus) was found nesting in a dead cottonwood tree about two miles from Lawrence, Kansas. This tree stands almost at the outer edge (western border) of a piece of pasture timberland comprising about six acres (Figs. 1,2,3). The plot contains almost no undergrowth; the trees are mostly cottonwoods and elms with a few hickories and hackberries. A young stream flows through the eastern part, its old channel forming a dry, shallow ravine at the western edge. The plot is about one quarter of a mile from a farmhouse and a half mile from the roadway. (Pl. I).

The particular tree chosen as the nesting site has a diameter of about two and a half feet with no branches nearer thantwenty feet from the ground. In 1921 the owls used an open nest. An old nest of a hawk or a crow is quite frequently made use of by this species (Reed 1913), although they occasionally build their own (Pearson 1921). Lantz (Bendire 1892) located twelve nests of this species. Three were old nests of the red-tailed hawk; one was an old nest of a crow; while eight were in hollow trees. B. F. Goss (Bendire 1892) drew the rather logical conclusion that the cavities of hollow trees were the natural nesting sites and that open nests were a matter of adaptation on the part of the species to changing conditions brought about by the destruction of such trees.

Fig.1. Nesting site; looking east, 400 ft. away.
Arrow indicates location of tree.

Fig.2. Looking north, 200 ft. away.

Fig.3. Looking east, 150 ft. away.

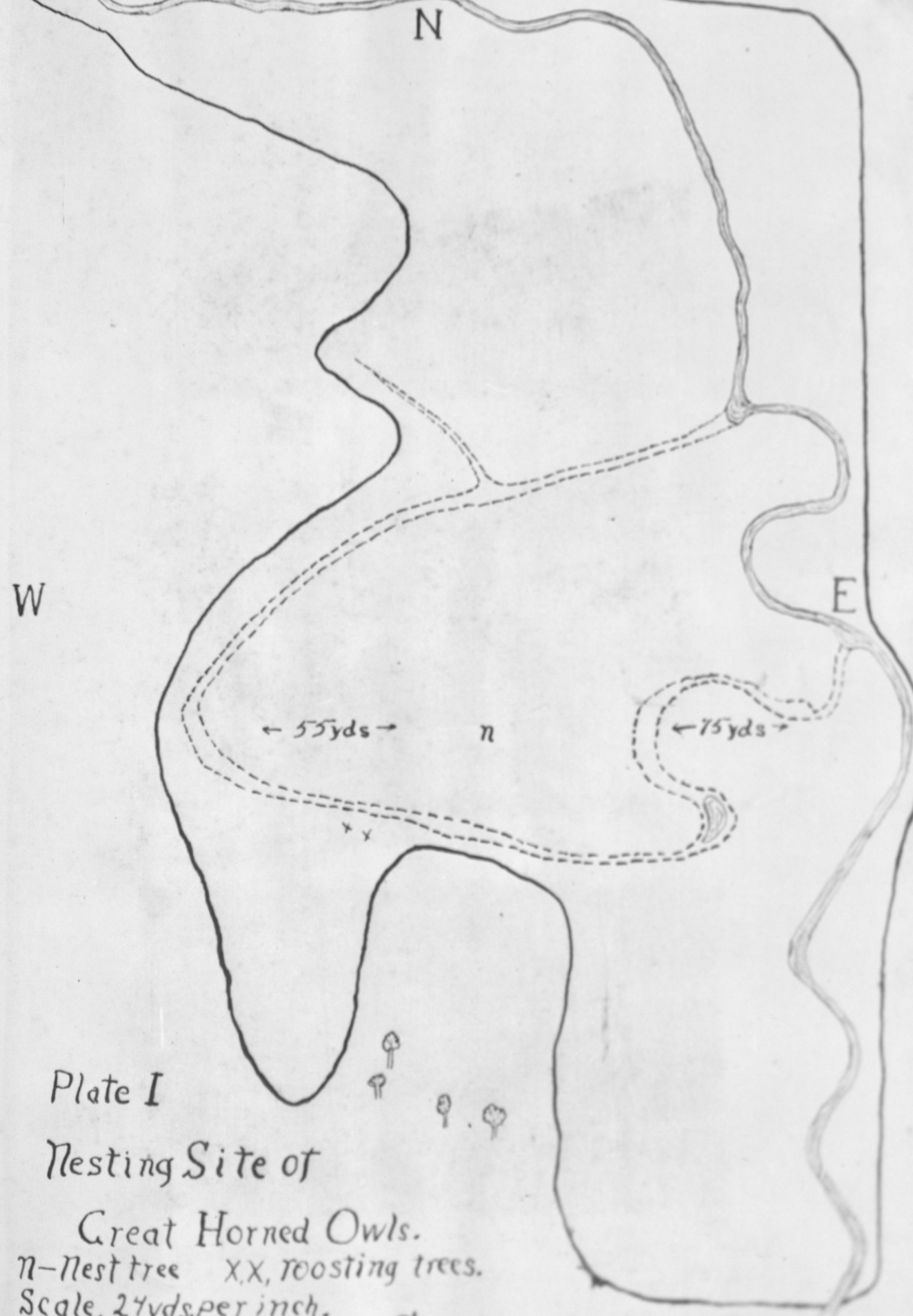


Plate I

Nesting Site of

Great Horned Owls.

n–Nest tree X X, roosting trees.

Scale, 24yds. per inch.

After 1921 this pair resorted to a cavity in the same cottonwood for nesting and from that time till the present (1923) has not used the open nest. This cavity is on the upper surface of a horizontal limb stretching to the south and about twenty feet from the ground. Sometime in the past a large branch evidently broke off from this limb and decay hollowed out this irregular opening about one foot across at its greatest extent (Figs.4,5).

From the time that the nesting site was discovered fresh pellets could be found under the nesting tree and in the immediate vicinity and on visiting the plot one or more of the adult birds was invariably flushed. On the last visit (September 22, 1923) neither of the adults was flushed and no pellets were present nor could any other evidence be found that they were still there. However, in the nesting season of 1923 the adults were known to have nested there although no close inspection of the nest was made.

On April 2, 1921, the open nest was blown out of the tree during a spring blizzard. Evidently there was but one owl in the brood of that season. This bird, which will hereafter be referred to as Number 1, was about five weeks old at the time and was covered by a fine, soft, down, cream buff in color. It was taken captive, the parents following at a respectful distance until the edge of the timber was reached. Close study was made of this specimen and data recorded even during the period, from five to eleven weeks, that it was in the possession of another party. From this time on during its captivity no attempt was made to tame it; as nearly as possible natural conditions were maintained. When it was four months and three weeks old (July) it escaped.

The study was not nearly completed so the next year (1922)

Fig.4. Looking upward from south side of tree. Location of nest cavity indicated by arrow.

Fig.5. Looking upward from west side.

one of that season's brood was removed from the nest on March 19. This bird, which will be alluded to as Number 2, was estimated to be about three weeks old at that time. It was one of a family of three. When taken it weighed one and a half pounds and had a wing spread of twenty-one inches. Its covering was not so heavy as that of Number 1 since it was two weeks younger.

On March 31 of the same year when Number 2 was supposed to be five weeks old some one shipped a young great horned owl from Missouri to the Dyche Museum of the University of Kansas to be mounted. It was judged too young for that purpose so it was given over for observation. It will be referred to as Number 3. It appeared to be about one week older than Number 2.

The individual hereafter designated as Number 4 was found along the roadside about one half mile south of the nesting site about April 1, 1923. It is not known whether it came from the same nest or not, although a pair of adult birds had nested in this same tree in 1923. It seems improbable that this nestling could have traveled that distance since it was too young to fly but no other pair was known to have nested anywhere else in that region. Its age was estimated to be about five weeks.

These young owls spent their captivity in a large shed, one side and one end of which was inclosed with woven wire. After more than a year of daily observation Numbers 2 and 3 were taken to a heavily timbered district about seven miles southwest of Lawrence and freed (April 7, 1923). Number 2 found its way back across open country to the western edge of the city (Lawrence). It was found roosting in a densely populated region and shot (June 4). Number 4 was taken to timberland about seven miles west of Lawrence and

freed on June 14, 1923, when it was about sixteen weeks old.

The estimates on the ages of these owls appear quite accurate when compared with the fledglings shown in Figs. 6, 7, (Dixon 1904). These latter had their ages definitely determined and in appearance resemble Number 2, (Figs. 8,10) at the same age. The same comparative size along with condition of plumage would seem to verify the estimated ages of Numbers 2 and 3.

Fig.6. Pacific Horned Owls 3 weeks old.(From Dixon,courtesy of Condor).

Fig.7. Pacific Horned Owls 5 weeks old.(From Dixon,courtesy of Condor).

Fig.8. Owl No.2 at estimated age of 3 weeks.

Fig.9. No.2,age 4 weeks.

Fig.10. No.2,5 weeks,(right);No.3,6 wks,(left).

VI. Records.

When Numbers 2, and 3 were taken an effort was made to follow development by recording accurate weights and measurements at regular intervals; the condensed results are shown in the accompanying curves. (Pls. II,III.) Weights for Number 2 were recorded weekly beginning with the estimated age of three weeks. Measurement of extent or wing spread was also begun at this time; body length was recorded for the first time at the age of four weeks. These records for Number 3 were begun at the estimated age of six weeks. All weight records were taken twelve hours after feeding with one exception,- in the case of Number 3 at the age of nine weeks when it was accidently fed immediately before weighing. The detailed figures are given in the tables and the curves were plotted from these.

Table 1. Correlation of Length and Age.

	Number 2.			Number 3.		
Date.	Age.	Length.	Increase.	Age.	Length.	Increase.
3/19/22	3 wks.					
3/26/22	4 "	10.5 in.				
4/2/22	5 "	13. "	2.5 in.	6 wks.	15 in.	
4/9/22	6 "	14. "	1 "	7 "	16 "	1 in.
4/16/22	7 "	16 "	2 "	8 "	17 "	1 "
4/23/22	8 "	17 "	1 "	9 "	18 "	1 "
4/30/22	9 "	17 "	0 "	10 "	18 "	0 "
5/7/22	10 "	19 "	2 "	11 "	18 "	0 "
5/14/22	11 "	19 "	0 "	12 "	19 "	1 "
5/21/22	12 "	19 "	0 "	13 "	19 "	0 "
5/28/22	13 "	20 "	1 "	14 "	20 "	1 "
6/4/22	14 "	20.5 "	0.5 "	15 "	20 "	0 "
6/11/22	15 "	20.5 "	0 "	16 "	20 "	0 "
6/18/22	16 "	20.5 "	0 "	17 "	20 "	0 "
7/16/22	20 "	21 "	0.5 "	21 "	21 "	1 "
4/1/23	57 "	21 "	0 "	58 "	21 "	0 "

Table 2. Correlation of Extent and Age.

	Number 2.			Number 3.		
Date.	Age.	Extent.	Increase.	Age	Extent.	Increase
3/19/22	3 wks.	21 in.				
3/26/22	4 "	26 "	4 in.			
4/2/22	5 "	33 "	7 "	6 wks.	36 in.	
4/9/22	6 "	40 "	7 "	7 "	42 "	6 in.
4/16/22	7 "	45 "	5 "	8 "	42 "	0 "
4/23/22	8 "	47 "	2 "	9 "	46 "	4 "
4/30/22	9 "	50 "	3 "	10 "	49 "	3 "
5/7/22	10 "	51 "	1 "	11 "	50 "	1 "
5/14/22	11 "	54 "	3 "	12 "	51 "	1 "
5/21/22	12 "	55 "	1 "	13 "	52 "	1 "
5/28/22	13 "	55 "	0 "	14 "	55.5 "	3.5"
6/4/22	14 "	55.5 "	0.5 "	15 "	56 "	0.5"
6/11/22	15 "	55.5 "	0 "	16 "	56 "	0 "
6/18/22	16 "	55.5 "	0 "	17 "	56 "	0 "
7/16/22	20 "	56 "	0.5 "	21 "	56 "	0 "
4/1/23	57- "	56 "	0 "	58- "	56 "	0 "

Table 3. Correlation of Age and Weight.

	Number 2.			Number 3.		
Date.	Age.	Weight.	Increase.	Age.	Weight.	Increase.
3/19/22	3 wks.	24 oz.				
3/26/22	4 "	29 "	5 oz.			
4/2/22	5 "	33 "	4 "	6 wks.	36 oz.	
4/9/22	6 "	36 "	3 "	7 "	42 "	6 oz.
4/16/22	7 "	36 "	0 "	8 "	42 "	0 "
4/23/22	8 "	39 "	3 "	9 "	56 "	14 "
4/30/22	9 "	40 "	1 "	10 "	52 "	-4 "
5/7/22	10 "	40 "	0 "	11 "	52 "	0 "
5/14/22	11 "	44 "	4 "	12 "	56 "	4 "
5/21/22	12 "	44 "	0 "	13 "	56 "	0 "
5/28/22	13 "	43 "	-1 "	14 "	53 "	-3 "
6/4/22	14 "	42 "	-1 "	15 "	52 "	-1 "
6/11/22	15 "	44 "	2 "	16 "	52 "	0 "
6/18/22	16 "	46 "	2 "	17 "	56 "	4 "
7/16/22	20 "	43 "	-3 "	21 "	56 "	0 "
4/1/23	57- "	43 "	0 "	58- "	56 "	0 "

Plate II. Owl #2. Growth Curves.

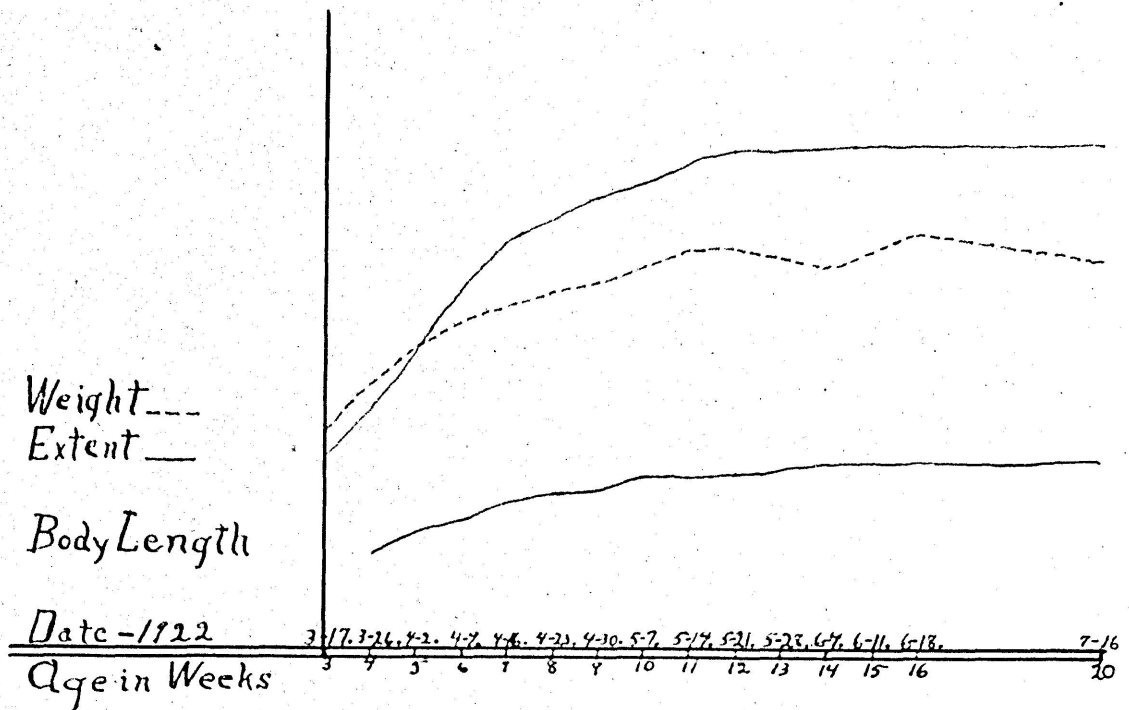
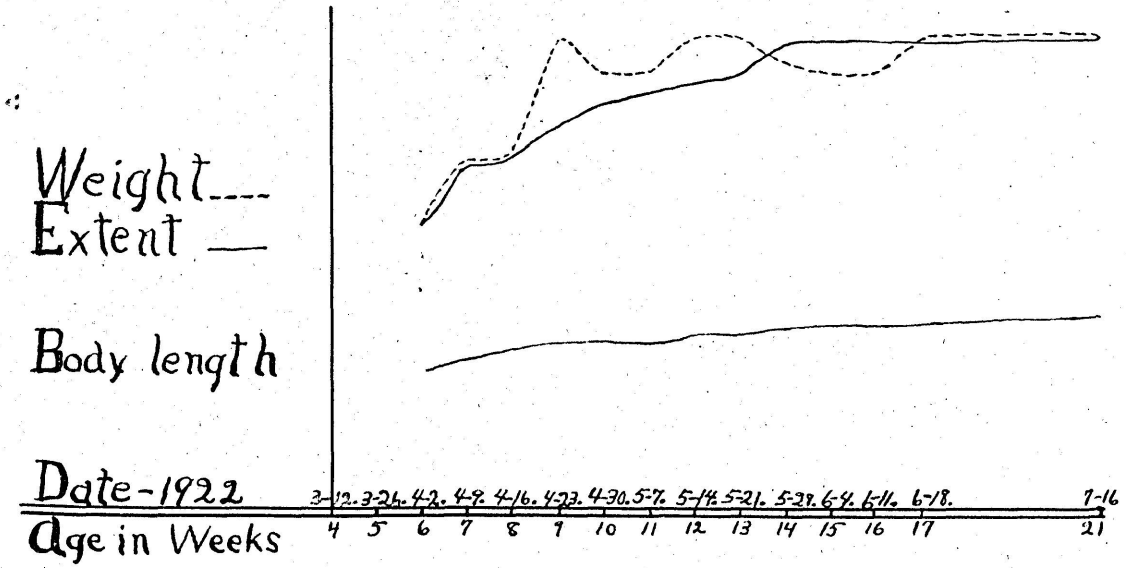


Plate III. Owl #3. Growth Curves.



The average specimen according to Pearson (1921) measures from the end of its bill to the tip of its tail two feet; the wing spread being four and one half feet and the weight from three to four and three fourths pounds.

Changes in appearance are also shown by the accompanying photographs (Figs. 8-16 inclusive). As is to be expected the curves ascend more rapidly in the earlier weeks reaching a stationary stage about the thirteenth or fourteenth week. A slight loss in weight is displayed by both, beginning at about twelve weeks. This might have been due to improper feeding but more probably was correlated with the very noticeable change in plumage which occurred at this time. Feathers are rapid in growth; this very rapidity is exhaustive to the vital energies, (Coues 1887). It is particularly noticeable that Number 2 never did attain the weight of Number 3 although the latter had the same adult wing spread and body length. Number 3 was, consequently, somewhat less active and did not learn to fly as early as Number 2. Number 2 was able to fly as much as 200 feet at the age of sixteen weeks but was not able to rise any distance in the air, while Number 3 did not fly more than fifteen or twenty feet at this age.

While it might be objected that these observations would not apply to nestlings under natural conditions it is never-the-less felt that the observations are of sufficient value to justify recording, since the curves are even and regular.

Fig.11. No.2,6wks.(left);No.3,7 wks.(right).

Fig.12. No.2,7 wks.(right);No.3,8 wks.(left).

Fig.13. No.2,8wks.(right);No.3,9 wks.(left).

Fig.14. No.2, 9 wks.(left);No.3, 10 wks. (right).

Fig.15. No.2, 11 wks.(left);No.3, 12 wks. (right).

Fig. 16. No.2, 20 wks. (right); No.3, 21 wks. (left).

Fig. 17. No.1 estimated 6 weeks old; two weeks after capture.

VII. Plumage.

At the age of three weeks the gray down (Job 1905) described as the first covering, was replaced by soft, fluffy feathers, the horns or ear tufts showing as little compact patches, slightly higher than the rest of the plumage. On the whole the color was cream buff with faint, indefinite streakings; the wings bore the most decided markings; the primaries and secondaries were becoming unsheathed. At the age of six weeks the wings and tail showed the most noticeable change in plumage (Figs. 17,28). At the ages of eight and nine weeks respectively both Numbers 2 and 3 showed the markings of the immature adult plumage although the fluffy, nestling feathers were still prominent. Some idea of the feathering as it took place on the body may be gained from Fig. 18. Here and there a long, well marked feather may be seen in contrast to the nestling feathers. The climax in the change in plumage seemed to come at about eleven weeks. From that time on the adult plumage was unsheathed rapidly; the well-defined facial disk, the white throat patch and the mottled ochraceous buff color all appearing in rapid succession until at the age of twenty-one weeks the adult plumage seemed to be complete except for the horns (Fig. 16); these are present although not shown in the illustration since the owls flattened them against their heads. These horns or ear tufts attained their full growth at about twenty-six weeks. Fig. 19. During this time the weight remained almost stationary; the food no doubt was utilized in supporting the drain made by the rapid feathering.

Baird, Brewer, and Ridgway (1874) evidently refer to the immature plumage in their statement that at the age of six weeks the feathers are nearly all grown except the head feathers which have

Fig. 18. No.1 at 12 weeks with nestling screech owl.

Fig.19. No.2 (right); No.3 (left), showing development of horn tufts.

hardly started. They further state that the full plumage was attained in less than eight months and that the specimen was full size in every way except the claws which were hardly half the usual size. Numbers 2 and 3 showed fully developed claws at the age of two months. Banks (1884) mentions that the horns are noticeable at the age of four months. Numbers 2 and 3 showed these horns quite plainly at the age of three weeks. He (Banks 1884) sets the time for full plumage at the age of six months. Barrows (1912) comments that the flight feathers are not acquired under two months.

VIII. Food Habits.

The great horned owl is crepuscular in habits rather than nocturnal; on bright, moonlight nights it might be called nocturnal. It is known to hunt on cloudy days and often when it has young it hunts indiscriminately day or night. Fisher (1893) classifies this species as partly beneficial and partly harmful. The main damage comes from raids made on poultry roosting in trees and could be avoided. Its favorite food consists of ground squirrels, gophers, prairie dogs, rabbits, skunks, rats, mice and other rodents that infest the fields. Cases have also been cited (Frazar 1877; Thoreau 1910) where fish has formed part of its diet. Donahue (1923) in his observations on the nesting of a pair of these owls found no evidence whatever of any chickens having been killed by them although there was a chicken farm within a half mile of the nesting site. Keyes (1911) makes no report of any poultry in the contents of nests although some birds are mentioned. He further states that the farmers living near a family of this species said that the large flocks of chickens had never suffered from its presence. Dixon (1904) further adds that it is far more of a benefit to the farmer and orchardist than a menace, basing his statement on observations extending over a series of years. When depredations do occur they are apt to be at the time when there are young to feed. The young grow slowly and remain in the nest from ten to twelve weeks (Fisher 1893); this means of course almost double the tax on the parents as compared to that imposed on any other land bird. The particular nest under discussion in this study was observed to be filled with bones and carcasses of various

mammals and rodents. No poultry was found in or about the nest though there were seven farmhouses within a radius of three-fourths of a mile.

From the very first in captivity all of these young owls ate sparrows, not infrequently taking as many as eight or ten in the course of a day as well as beef kidney and liver to the extent of one half pound each. On one occasion when about ten weeks old Number 1 ate fourteen sparrows and one-fourth pound of beef kidney at one feeding. Each one showed a decided preference for kidney, caring the less for liver. Their appetites were more easily satisfied as they grew older.

Sparrows were easily available through the activities of a licensed trapping station, while dead guinea pigs and rabbits as well as mice and rats were obtained from laboratory experiments. Feathers, hide, and fur were always swallowed, the plucking or skinning process being done in the owl stomach (Pearson 1921). These, along with the bones,were rolled into a compact mass and afterwards regurgitated, usually in about twelve hours. When living on an exclusive diet of raw meat from the butcher shop for a few days the birds readily devoured feathers from a plucked chicken in considerable quantities. A taxidermist's laboratory furnished from a green heron a tuft of feathers measuring ten inches in length. It was rather stiff but one of the birds swallowed it in a period of little over one minute.

Sparrows were usually swallowed whole although the head was sometimes crushed or torn off; the body was invariably swallowed head first. It was also noticed that food was taken at definite intervals; and if a pellet was about to be regurgitated no food was eaten until it was ejected. The manner of taking food was

usually after this fashion: the bird would pounce upon a morsel, for example, a sparrow, sometimes striking it first with the beak, or perhaps with the talons, but in every case it took the bird up in its beak, lowered its head and grasped the sparrow with a foot, usually the right. Holding its quarry thus it would glance quickly about for a possible enemy, then it might hop or fly to some other perch, always keeping a sharp lookout. At times this attitude was maintained for as much as ten minutes. If any tearing was done it was held down with this foot; after being minutely inspected the sparrow was then finally swallowed. Figures 20,21,22,23 illustrate this procedure. Guinea pigs were usually torn considerably and the skulls frequently crushed, but not always, as pellets were often discovered containing almost intact skulls. Aside from this none of these birds were observed to crush bones with any apparent intent. Both beak and talons were possessed of great strength but the former had very little shearing power.

Surplus bits of food were sometimes left lying where dropped but more frequently they were carried to some corner and often covered with sticks or other refuse, later to be brought out and sometimes eaten but as a rule they were pulled about, played with, hidden somewhere else and finally discarded as if forgotten.

The pellets (Fig. 24) were usually coated with a thick layer of mucus and never contained any other material save feathers, hair, fur, and cleanly polished bones. Neither muscle, cartilage nor tendons was ever found attached to any pieces of bones. The latter, however, were never corroded in any way so thay had never been acted upon by the digestive juices. The spongy epiphyses were sometimes

Fig.20. No.1. First step of swallowing sparrow, grasping in mandibles.

Fig.21. Second step of swallowing sparrow; lowering sparrow to grasp in talons.

Fig. 22. Third step; after lifting in talons, swallowing head first by series of quick backward jerks of head.

Fig. 23. Fourth and last step in process.

Fig. 24. Pellets. Nos. 1, 3, 4, 5, 6, 8, 9, 10, 12, and 15 mainly fur and bones of guinea pigs and rats. Nos. 2, 7, 11, 13, and 17 composed mostly of feathers and bones of sparrows; note bills, also in No. 24.

Nos. 14 and 19, major portions of skulls of guinea pigs.

Nos. 16, 20, 21, and 22, miscellaneous collections of small bones found in pellets.

No. 18, mandibles of guinea pigs.

No. 23, petrous bones of skulls of guinea pigs.

Fig. 24.

found collapsed and broken but this seems to have occurred before swallowing. Microscopic evidence showed that hair and feathers were in no way affected by the digestive juices, although the quills of large feathers were always splintered and rolled together. On a number of occasions pellets were found that contained hair of two different colors or hair and feathers in which the masses were not mixed at all but were very sharply delimited, indicating that two particles swallowed at different times were not mixed together. If a mouse and a bird were fed at the same time the fur and feathers came up mixed in the same pellet, but if fed separately at an interval of a half hour the fur and feathers appeared in the same pellet but distinctly separated. This was also true of animals of the same species but different in color. The literature gives no solution to this problem of pellet formation; the study, however, is to be continued along this line.

None of the captives had any occasion to kill their food. Numbers 2, and 3 lived in a shed most of the period of captivity with two short-eared owls which were, to the best of the observer's knowledge, never injured intentionally by them, although they readily devoured one of the short-eared owls which died from another cause. Widmann (1907) mentions a case of a captive male eating its dead mate; he also states that a crow lived with the pair for about a year and was unharmed. One incident is given (Baird, Brewer and Ridgway, 1874) where the female in confinement killed and ate the male.

IX. Calls.

The first manifestation of any call given by the four owls was a hiss very frequently employed even when the birds were first taken. When four or five weeks old a shrill, short "yeep" similar to that of a young chicken was given; this was evidently expressive of recognition or interest. Numbers 1,2, and 4 gave this call rather persistently. Another call correlated with anger and excitement might be described as a longer and more quavering one; similar to the long drawn night call of a screech owl but more harsh and staccato. This was noticeable at the age of seven weeks whenever they were disturbed. The only other distinct call recognized was the characteristic hoot. Number 1 displayed this only a few times and then it was very immature, the note being shrill and high pitched. Number 2 began its attempts at hooting at five and a half months. By the age of six months it was able to hoot in rather characteristic fashion although volume was lacking. A month later it was responding to the steamboat whistle of a switch engine which regularly blew about nine o'clock each night; each blast from the engine brought forth an answering hoot. Number 3 was not inclined to hiss frequently and was seldom ever heard to give the "yeep" call. It was never known to hoot or even try it. It also gave the scream of anger less often than Number 2. Number 4 was very similar to Number 2 except for the hoot and it had not reached the age for that when liberated.

The age at which hooting began as given by Coues (Lockwood 1877) is four months and then only while at liberty during the night. The anger call of a young great horned owl in captivity is described by Banks(1884) as a sharp shrill cry with a vibration similar to that

produced by a "pea whistle"; this same call being given when it was annoyed. He also tells of another sound which resembled so closely the creaking of the door hinge that he was inclined to believe that the owl had imitated it. He gives no age when the hooting began but states that the hoot was made with the bill firmly closed, the air forced into the mouth and upper part of the throat, the latter being puffed out to the size of a large orange. This procedure corresponds quite closely to the method of Number 2. The calls of the adults are described by Bendire (1892) as the "to-hoot-to-hoot-to-hoot" of the male and the "oo" or "to-oo" of the female along with a series of yelps and the cat-like cry "waah-hu". Pearson (1921) phrases the hoot in the syllables of "whoo, hoo-hoo-hoo, whooo,whooo"; while another call he mentions as "a blood-curdling scream". Eaton (1914) gives it as six syllables, "whoo-hoo-hoo-hoo-whoo-whoo" all on the same key and says that it is often mistaken for the tooting of a locomotive. This last statement justifies the mistake of Number 2 when it regularly answered the switch engine.

X. The Eye.

The eyes of Number 2 at the age of three weeks showed a washed-out pale yellow iris and a milky cornea; Numbers 1, 3, and 4 still showed this to some degree at the age of five weeks. Keyes (1911) describes the iris as milky yellow or light lemon yellow in nestlings a little more than a week old. This corneal opacity did not disappear completely until the owls were six weeks of age. Fig. 25 shows how clear the eye became at the age of eight or nine weeks. The iris gradually became more highly saturated until it reached the chrome yellow stage at about two months. The same observations were noted on each of the four owls as those mentioned by Coues (1874), viz., that the iris was entirely under the control of the will instead of being automatically dependent, as commonly supposed, on the stimulus of light; each owl could readily contract or relax the quivering iris in accomodating its vision to different objects or different distances; the two irides could move independently of each other. They often looked at something with one eye partly closed; Number 3 did this more frequently than the others. Usually, on such occasions the pupils differed in size. But in all stages of contraction and dilation the pupils remained circular.

Whenever the pupils were much dilated either from anger or some other cause the irides (especially in the chrome-yellow stage) took on a reddish tinge. This was no doubt the result of capillary dilatation,- the dilatation of the pupils giving the blood vessels in the irides more chance to distend.

Fig.25. No.4, showing clear cornea and aqueous. 8 or 9 weeks old.

Fig.26. No.1, showing semicircle marked by x.

Fig.27. No.2(right); No.3(left). Note method of grasping perch.

The eyesight was keen even in broad daylight, although the bright sunlight was apparently irritating and caused ciliary constriction until a pin point pupil resulted. It was noticeable, however, especially under the ages of five to six weeks, that the eyes were quite sensitive to strong light. Number 2 when under that age would seek dark corners; Numbers 1, 3, and 4 did it to some extent even at the age of five and six weeks. When older, for that matter, they all preferred a shaded spot to the glare of the sun. Number 1 watched the buzzing of a fly about a basement room where the light was less than 1/10 foot candle intensity; when out in the bright light of the noon day sun, it also followed the movements of a dog a block away; at another time it watched the flight of a robin from a distance of 300 feet.

All four of the owls seemed to enjoy watching the outside world from the open side of the shed. They would perch there in the daytime as well as at night. It was no unusual occurrence for them, expecially Number 2, to catch sight of motion at the windows of the house forty feet away; these motions were caught equally well from the second and third stories as from the first.

All but Number 3 frequently displayed a movement of the body from side to side when looking at something. This was most apt to occur when the object was stationary or when something excited the curiosity and they were not able at once to recognize it. This may have been due to retinal fatigue or it may have been an effort to get a different angle of vision; more probably it was the result of both. Banks (1884) mentions this same motion on one occasion when the captive owl was about to attack a cock placed in its pen and he comments that it appeared to be calculating dis-

tance. This same reaction was manifested by Number 1 when a flashlight was flashed in its eyes; it probably was an effort to see into the darkened area behind the light.

The acuteness of vision is further borne out by Coues (1874). He noticed his two fledgings follow the motions of a grasshopper or butterfly flickering several yards up in the air. On one occasion they watched, facing the glare of the sun, a pair of white cranes floating in circles a half mile high. This is quite different from the statement of Willitts (1919) when he mentions that his captive "perhaps did not see you unless very near". Our own observation confirms Coues (1874) that they have a very acute vision. The eye, however, seems to be adapted for movement and contrast rather than for discrimination as evidenced by the fact that each of the four owls would seize its own wing if it happened to pass the line of vision.

This reaction to contrast was quite marked at an early age in case of Numbers 1, 2, and 4. If a dark dress with white collar and cuffs was worn near any one of them, that one would at once begin pulling at the white area with its beak; a white shirt front exposed by an open coat would also bring a like response, the owl running its beak up and down the shirt front along the lines of contrast formed by the edges of the coat. At different times it spent as much as ten minutes on this problem. Color did not seem to affect any one of them unless the element of contrast was great enough in light and dark. Bolles (1892) suggested that the species may have an appreciation of color because of the fact that they choose brown-trunked trees for nesting and other purposes. Num-

ber 3 showed interest to some degree but it never responded to anything as did the others; its nature or disposition was entirely different.

The eyes are fixed in the sockets and are incapable of motion, their direction being at an angle of about 60 degrees (Audubon 1849). This accounts for the movement of the entire head when an object is to be kept in the line of vision. The nictitating membrane or "third eyelid", possibly functions to protect from extreme light (Knight 1908).

XI. The Ear.

Cassell (1854) describes the auditory cavities within the skull as prodigiously enlarged with the external orifice proportionate. This orifice is concealed between two extensive membraneous valves from the edges of which proceed the feathers which form the outer view of the disc which encircles the face. Fig. 26 shows where these two valves may be opened to reveal the cavities. The leaves of the double valve are capable of being thrown apart so as to give the freest entrance to every slight vibration of the air and then to concentrate it; the effect is increased by cavities connected with the internal mechanism so widely diffused that the owl hears with the greatest distinctness the faintest noise as the cry of a mouse or even its rustle among the straw. Cassell's (1854) comment on the acuteness of hearing is further strengthened by Banks (1884) and Bolles (1892). The latter claims that it is much more acute than that of man.

The observations on the four captives likewise verify this acuteness. It was almost impossible to surprise any one of them in the shed although the approach was made as cautiously as possible and from the side where no glimpse of the observer could be obtained. Not only was it possible for them to hear the slightest sound but they could readily localize it. Experiments were made where the observer, concealed, gave various sounds and each time the direction was localized. A tapping on the attic window when one of the captives was perched at the open side of the shed invariably brought a response, the one in question focusing its vision at the origin of the noise.

The horns or ear tufts do not seem to be a part of the ear proper. So far no statement as to their exact function has been found. These tufts according to Audubon (1849) are composed of two series of nine feathers, there being eighteen in each tuft; the two rows are parallel and close together and are about three inches in height. All of the captives showed a control over these tufts; raising or lowering them at will. Are these tufts in some way connected with the muscular control of the ear valves or are they merely a part of the protective adaption of this species ? These questions remain for further investigations on the part of the observer.

XII. Smell.

The sense of smell has not been investigated in this study as thoroughly as it will be in the future. Such observations as have been made seem to bear out the statement of Bolles (1892). He made tests with fumes of camphor, ammonia and other unusual and disagreeable odors but got no reaction unless the fumes were strong enough to affect the breathing or to irritate the eyes. His captive could be ever so hungry and yet never suspect the presence of food if the latter was carefully covered so it could not be seen. He further states that it disliked putrid meat but that it always tasted it before rejecting it. This last was also true of the four owls observed in this study. Bolles concludes that he found no satisfactory evidence of olfaction of a high degree of acuity. Further experiments will have to be completed before this study confirms the verdict as absolute.

XIII. Perching and Attitude of Repose.

The talons are singularly hooked (Cassell 1854), acute, and highly retractile, the outer toe oppoaable (Allen, 1918; Newton 1899; Coues 1887). It was, however, unusual for any of the four captives to demonstrate the opposability of the outer toe. Only on one or two occasions was it ever noticed (Fig. 27). The ordinary way of perching was with three toes in front and one behind. This was used to a large extent when clinging or trying to climb. (Fig. 28). When standing the claws were as a rule spread as in Fig. 29. From the very first the talons possessed great strength and this increased with age (Fig. 30), prehension being well developed at the early age of three weeks. A grip around a finger was sufficient to cause pain even though the nails were not piercing. When full grown the pressure from the claws would be equivalent, if not greater than, that of the hand of a strong man. It was almost impossible to open the closed claws. Each one of these young owls seemed to like sitting back on the hocks with claws closed; that part of the leg was kept rather bare of feathers for that reason. When perching the common attitude was with the three toes hooked over the perch in front and one at the back; when entirely quiet or at rest the talons were usually closed; the body resting on the tarsus extended along the surface of the perch. At such times the head faced toward the front with both or possibly one eye closed or both wide open.

Fig.28. No.1, estimated 6 weeks old.

Fig.29. No.2, left; No.3, right.

Fig.30. No.1, 5 weeks old, showing prehension.

XIV. Reactions or Behavior.

From the time of the capture of Number I until the age of eleven weeks no restraint was put upon its freedom. It roamed about the premises; climbed into dark corners under a shed roof; hid under the porch or perched in some tree. It would come in response to a high pitched call of "woo, woo, woo", long drawn out. If one talked to it in a gentle, soothing tone it would give a series of soft, quavering notes and nestle closer to the speaker. When ten weeks old it would sometimes fly as far as a mile; doing so by stopping intermittently to rest. It would be gone an hour or even a half day but it always came back. It did this one day when a flock of crows were in hot pursuit; they seemed not to confuse it in the least. One night after its freedom had been taken from it, it escaped from the shed but instead of flying away it came and perched on a ladder on the porch where the light from the open door was brightest. When approached it stepped upon the extended arm and submitted to captivity without any protests.

After it had reached the age of about twelve weeks or more its talons had become so powerful in grip as well as piercing that heavy leather gloves were used when it had to be handled. However, there was never any occasion when it seemed to wound intentionally. It appeared to take a dislike to the gloves. These were often thrown down in its shed for ready use. Time after time, in fact every time that they were so left, the owl would hide them in some corner or under the cushion of an old wicker chair. Again it would drag them through its pan of water

and leave them soaking wet on the ground. This might have been partly an instinct to play but since it never did the same with other articles left lying about it would seem to indicate more of a dislike. Bolles (1892) mentions a captive Snowy Owl that showed great antipathy for a piece of cloth that was used for covering its head when the owl was taken out into the open.

When Number 1 was taken out of the shed for exercise it would crouch low as birds of all kinds gathered and scolded, some even darting down for a swoop at it; its mere presence was a signal for all other birds to make an attack. At such times it showed some excitement although it might have been merely an effort on its part to get away from its enemies; this was shown by its flying up to the roof of the house or into a tree. Often when trying for some destination like that it would find itself brought to a dead stop by the rope attached to a leather band on one leg. It would invariably look back as if puzzled and often make another start; after several efforts it would give up until it was brought back and the rope's length was again available. A rather sharp instinctive response always followed the blowing upon the back of its head in imitation of the air current produced by the swoop of a bird; this was evidently a protective reaction. All of the others acted in the same manner with the exception of Number 3; it didn't show quite the same reactions or rather it did not manifest them as often. When from an unseen source the call of a screech owl was given, Number 1 invariably localized the sound at once and made an attempt to gain sight of the one giving it.

Number 2 when but three weeks old showed a decided tendency to play. In its awkward way it would seem to measure off on the floor a certain distance and then jump; or it would sedately walk or rather wobble over to the stairs, scrutinize them carefully and then with the aid of the wings hop them one at a time, each time investigating the one just above. Its maneuvers resembled those of a small boy. When a mounted bird was placed near by it would look at it very closely for a time and then lose interest; there was no contrast nor motion to hold its attention. Like Number 1 it was always on the lookout for a dark corner where the light was not so intense; this was true even of the artificial light at night when the bird was still very young. It was a friendly owl and made friends with the two short-eared owls; not infrequently it would be found sitting or perching close to the side of one watching the outside world from the open front of the shed. Its overtures with Number 3 were not encouraged until after both were well grown and then there was only a very formal relation between them. When Number 3 first appeared on the scene Number 2 wobbled over to get acquainted. Its advances were repulsed repeatedly until finally Number 2 seemed to lose its good nature and became apparently so disgusted that it could do nothing but clap its beak; a series of claps followed as though it could not quit; it finally turned its back to Number 3 and wobbled away clapping as it went and made no more advances for some days.

Gleeson (1904) mentions the sulkiness of his captive when teased with a piece of meat held just out of reach. It would stretch and reach for it until it tumbled off the perch and then it would go off to the farthest corner and stand with its back turned like a pouting child.

Of the four captives Number 2 was by far the most gentle and most easily handled. Usually if the others were quiet and didn't get it excited no trouble was ever encountered when it was to be weighed or measured. And if it did become frightened it was, as a rule, calmed by talking to it in gentle tones and allowing it plenty of time to step upon the outstretched hand. At night when a light was in a second floor room facing the shed Number 2 would perch at the open front and begin a "lonesome" call as if to attract attention. If spoken to it would invariably answer.

Number 3 was altogether a different individual from Numbers 1, 2, and 4. All three of these had good dispositions and seemed alert and interested in everything; but Number 3 was savage and surly from the very first. Its favorite reaction to feeding and to experiments was a sitting back on its haunches or lying flat on its back and attacking with claws and beak. All efforts at teaching it to behave differently were futile. Its ferocity was met by various punishments. When it struck at the observer with claws, a rod was manipulated so that the talons closed about it. From this the owl was suspended head downward. Neither swinging back and forth nor the deluge of a stream of cold water ever loosened its grip. If the attack came from its beak a hot poker or lighted

match received the assault but never stopped it. Holding its feet and pinioning the neck to the ground was likewise ineffective as well as boxing it to one side with enough force to upset its balance. It could be subdued for the time being but the process had to be repeated; the degree of severity of the punishment varied with the interval of time that followed each one. It seemed to remember but its savageness was not to be conquered. It also recognized the observer the same as did the other three owls. This matter of memory in birds is borne out by Hornaday (1922). As it grew older, feeding brought the fighting response less frequently providing no stranger attempted to perform the task. Whenever it was perched overhead care had to be used to prevent an attack; sometimes it would fly directly at the observer. This was attributed partly to fear and dread of the touch of a human hand. Nevertheless there was always a certain viciousness about it that led to the supposition that it really cared to fight. Whenever one of the others manifested any inclination to fly at the observer it was done in a fashion that plainly showed it was no direct attack but merely a getting somewhere because of excitement or fright.

Number 3 was always surly, sullen and morose. Its responses never came as freely as in the case of the others. These facts along with its larger size and different coloring led to the belief that it was a female and that the others were males. When it came time for the placing of a band on its leg for identification it took all the force of two adult persons to hold it while the third did the banding; it was then full grown.

Number 4 seemed more active at the age of five weeks than any of the others; it climbed higher and made better use of the perches. Like Numbers 1, and 2, it was always docile.

All of them except Number 3 spent no little time playing with white rags hanging in strips from the roof of the shed. This was done after observation showed their keen interest in light and dark areas. If a quick, sudden movement was made in the direction of any one of them it brought a fluffing out of the feathers, a hiss, and clap of the beak or a series of claps and an effort to strike with it. But if the approach was made cautiously, giving them time to puzzle it out, there was practically none of this reaction except with Number 3. A surprise would often bring the clapping of the beak and Number 2 would often hoot when taken unawares. All of them as Bolles (1892) describes his captive doing would fluff out to a mass of feathers a yard wide (wings being pushed forward and dragging the ground), sway from side to side, snap the beak like a pair of castenets, and open and shut the eyes all the while contracting and dilating the pupils in a way worthy of a Chinese dragon. Possibly this attitude affords as much protection as does the one in which they assume a sleek, slender, upright position with the two tufts erect in the form of a snag or broken limb.

Each of the owls moved the head, describing three fourths of a circle when attempting to keep something within the line of vision. Anything unusual when carried into the shed caused more or less excitement. A stick, broom handle or anything long and slender when pushed toward them threw them into a panic; this was expecially true when it was moved along on the ground in

front of them and in their direction. This was manifested even at the age of three weeks. It was possibly some instinct of fear though whether it had a connection with snakes was not decided. All liked to bathe, although Number 1 did so most frequently. It took a daily five minute plunge. With the exception of Number 3 each liked to have the back of its head stroked.

Bolles (1892) who had a captive great horned owl, along with others of different species, found that it had a temper which it hid under a dignified reserve and also that the memory was good. Widmann (1907) had a great horned owl in 1907 that was then passing its twenty-ninth year in captivity. His article about it is very brief but his observations are of interest. The captive was a male and for seven years it had a mate. This mate deposited two eggs but she was found dead and the male eating her before incubation had scarcely begun. The hooting of the male brought other females and one tried to get into the cage. The hooting began in September and continued till February. If a mouse and a sparrow were given to it at the same time it would eat the mouse first. Banks (1884) also mentions that his captive female when about a year old made two attempts at nest building but finally relinquished the idea and shortly after began to shed her feathers. The captives, Numbers 2, and 3 of this study, showed no inclination toward courting; nor did Number 3 make any attempt at nest building although material and a cavity were provided by way of an inducement. This led to the supposition, not yet fully confirmed, that perhaps there was no mating until the second year, but that it might be possible to get them to breed

in captivity providing the right sort of food in proper amounts was supplied along with favorable conditions. The observations of Bolles (1892) and Banks (1884) as stated above seem to confirm this possibility. Banks also notes the same behavior in regard to the pellets as was found true of all the four owls of this study. Namely that at the time a pellet was about to be ejected the bird seemed almost ill; sitting quietly and taking no food until the regurgitation took place and then it was all bright and ready for its meal. His captive manifested the same tendency at hiding surplus food. It too was fond of bathing; one daily bath in warm weather and one every three or four days in winter. Spreadborough (Macoun and Macoun 1909) concludes that the birds at liberty are fond of bathing.

Baird, Brewer, and Ridgway (1874) and McBride (Butler 1897) class the great horned owl as untameable; while Coues (Lockwood 1877) Widmann (1907), and Figuier (1870) claim that it may be tamed. The behavior of Numbers 1, 2, and 4 would lead to the belief that some great horned owls would respond and be easily tamed. No effort to tame was made in the case of these three; and yet they showed gentle dispositions that could easily be cultivated. (Figs. 31,32,33, 34). As far as Number 3 was concerned the natural conclusion is that there are others of the same species that are not easily if ever tamed. There are individual differences amoung birds as well as among members of the human race.

Fig.31. No.1 at 6 weeks.

Fig.32. No.1 at about 10 weeks.

Fig.33. No.2.

Fig.34. No.4.

Summary.

1. The incubation period of the great horned owl (Bubo virginianus virginianus) is twenty-eight or thirty days.

2. As far as body length, wing spread, and weight are concerned the owl of this species is full grown at the age of twenty to twenty-one weeks.

3. The adult plumage is complete at the end of twenty-one weeks with the exception of the horns. These attain their average size in twenty-six weeks.

4. The great horned owl is probably more beneficial than injurious. Its habits to a large extent are direct results of its environment. Its good and evil qualities ought to be measured according to its particular locality and to the prevailing conditions. It is a slow breeder and under present persecution it is more apt to become extinct than too numerous.

5. Hooting is attempted at the age of four or five months.

6. The vision is decidedly keen in both daytime and at night. The eye is adapted for perception of movement and contrast rather that for discrimination.

7. The hearing is very acute; more so than that of man.

8. There is no satisfactory evidence of olfaction of a high degree of acuity.

9. While the outer toe is opposable, the opposability is not so commonly made use of. The talons are proportionately stronger in gripping power than the hand of a strong man.

10. In the matter of behavior the young great horned owl shows a tendency to play. It apparently manifests dislike as well as anger. There is evidently present certain power of memory. At times the evidence of lonesomeness is displayed. As a species there may be the same general reactions but at the same time there are individual differences which distinguish each one just as in the human race.

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